Claims

[c1] A method for evaluating formation fluids, comprising:

acquiring a nuclear magnetic resonance measurement;
acquiring a dielectric measurement; and
determining an oil volume fraction from the nuclear magnetic resonance measurement and the dielectric measurement.

[c2] The method of claim 1, wherein the nuclear magnetic resonance measurement comprises at least one spin echo amplitude.

[c3] The method of claim 2, wherein the acquiring the nuclear magnetic resonance measurement uses a polarization time sufficiently long so that nuclear spins are substantially polarized.

[c4] The method of claim 1, wherein the dielectric measurement comprises an electromagnetic wave phase shift.

[c5] The method of claim 1, wherein the formation fluids comprise fluids in a formation traversed by a borehole drilled with a water-based drilling fluid.

[c6] The method of claim 5, wherein the acquiring the nuclear magnetic resonance measurement and the acquiring the dielectric measurement are performed while drilling.

[c7] The method of claim 5, further comprising:

determining a water-filled porosity from the dielectric measurement;
determining a total formation porosity from the nuclear magnetic resonance measurement; and
determining an oil-filled porosity by subtracting the water-filled porosity from the total formation porosity.

[c8] The method of claim 5, wherein the dielectric measurement comprises an electromagnetic wave attenuation.

[c9]

The method of claim 8, further comprising:

determining a total formation porosity from the nuclear magnetic resonance measurement; and

calculating a salinity of a brine in the formation based on the total formation porosity and a known aqueous phase attenuation function with respect to the salinity and a formation temperature.

[c10] The method of claim 1, wherein the formation fluids comprise at least one sample withdrawn from a formation traversed by a borehole, and a sum of an oil volume fraction and a water volume fraction is taken to be one.

[c11] The method of claim 10, further comprising:

determining a total volume of the formation fluids from the nuclear magnetic resonance measurement;

determining the water volume fraction of the formation fluids from the dielectric measurement; and

determining the oil volume fraction of the formation fluids by subtracting the water volume fraction of the formation fluids from the total volume of the formation fluids.

[c12] The method of claim 10, wherein the dielectric measurement comprises an electromagnetic wave attenuation.

[c13] The method of claim 12, further comprising calculating a salinity of a brine in the sample based on a total volume of the formation fluids and a known aqueous phase attenuation function with respect to the salinity and a fluid temperature.

[c14] A method for evaluating a volume of formation fluids, comprising:

acquiring a nuclear magnetic resonance measurement;

acquiring a dielectric measurement;

acquiring a bulk density measurement; and

solving a set of linear response equations representing a reservoir fluid model to determine fractional fluid volumes from the nuclear magnetic resonance measurement, the dielectric measurement, and the bulk density measurement.

[c15] The method of claim 14, wherein the reservoir fluid model comprises a representation of a non-gas bearing formation, the fractional fluid volumes comprise a water volume fraction, an oil volume fraction, and an oil-based mud filtrate volume fraction, and the set of linear response equations comprises:

nuclear magnetic resonance response equation that defines a total volume of the formation fluids with respect to the oil volume fraction, the water volume fraction, and the oil-based mud filtrate volume fraction;

a dielectric response equation that defines an electromagnetic wave travel time with respect to the oil volume fraction and oil travel time, the water volume fraction and a water travel time, and the oil-based mud filtrate volume fraction and an oil-based mud filtrate travel time; and

a density response equation that defines the bulk density with respect to an oil density and the oil volume fraction, a water density and the water volume fraction, and an oil-based mud filtrate density and the oil-based mud filtrate volume fraction.

[c16] The method of claim 15, wherein the formation fluids comprise fluids in a formation traversed by a borehole drilled using an oil-based drilling fluid, the electromagnetic wave travel time is a formation electromagnetic wave travel time, the bulk density comprises a formation bulk density, the total volume of the formation fluids comprises a total formation porosity, the oil volume fraction comprises an oil-filled porosity, the water volume fraction comprises a water-filled porosity, and the oil-based mud filtrate volume fraction comprises an oil-based mud filtrate porosity.

[c17] The method of claim 16, wherein the oil-filled porosity and the oil-based mud filtrate porosity are inseparable and the reservoir fluid model comprises a water phase and a combined oil and oil-based mud filtrate phase.

[c18] The method of claim 16, wherein the dielectric measurement comprises a measurement of a complex dielectric constant of the formation.

[c19] The method of claim 16 further comprising calculating a salinity of a connate water in the formation based on the total formation porosity and a known

aqueous phase attenuation function with respect to the salinity and a formation temperature.

[c20] The method of claim 15, wherein the formation fluids comprise at least one sample taken from a formation traversed by a borehole, and a sum of the oil volume fraction, the water volume fraction, and the oil-based mud filtrate volume fraction is taken to be one.

[c21] The method of claim 20, wherein the at least one sample is withdrawn such that it comprises substantially native formation fluids and the oil-based mud filtrate volume fraction is zero.

[c22] The method of claim 14, wherein the reservoir fluid model comprises a representation of a gas-bearing formation, the fractional fluid volumes comprise a gas volume fraction, a water volume fraction, and a gas-corrected total volume, and the set of linear response equations comprises:

an nuclear magnetic resonance response equation that defines the total volume of the formation fluids with respect to the gas volume fraction, a water volume fraction, and a gas-corrected total volume;

a dielectric response equation that is adapted for the gas-bearing formation by defining an electromagnetic wave travel time with respect to the gas volume fraction and a gas travel time, the water volume fraction and a water travel time, and the gas-corrected total volume and a gas-corrected travel time; and

a density response equation that is adapted for the gas-bearing formation by defining the bulk density measurement with respect to the gas volume fraction and a gas density, the water volume fraction and a water density, and the gas-corrected total volume and a gas-corrected total density.

[c23] The method of claim 22, wherein the formation fluids comprise fluids in a formation traversed by a borehole, the electromagnetic wave travel time is a formation electromagnetic wave travel time, the bulk density comprises a formation bulk density, the total volume of the formation fluids comprises a total formation porosity, the gas volume fraction comprises a gas-filled

porosity, the water volume fraction comprises a water-filled porosity, and the gas-corrected total volume comprises a gas-corrected total formation porosity.

[c24] The method of claim 22, wherein the formation fluids comprise at least one sample taken from a formation traversed by a borehole, and a sum of the gas-filled porosity and the water-filled porosity is taken to be one.

[c25] A method for evaluating formation fluids of a gas-bearing formation, comprising:

acquiring a bulk density measurement;
acquiring a dielectric measurement; and
determining a gas-corrected fluid volume from the bulk density measurement and the dielectric measurement.

[c26] The method of claim 25, wherein the formation fluids comprise fluids in a formation traversed by a borehole, the bulk density measurement comprises a formation bulk density measurement, the dielectric measurement comprises a formation travel time measurement, and the gas-corrected fluid volume is a gas-corrected porosity.

[c27] The method of claim 25, wherein the formation fluids comprise at least one sample taken from a formation traversed by a borehole.

[c28] A method for evaluating a formation traversed by a borehole, comprising:

acquiring a nuclear magnetic resonance measurement;
acquiring a dielectric measurement; and
determining a rock-matrix travel time from the nuclear magnetic resonance measurement and the dielectric measurement.

[c29] The method of claim 28, further comprising determining a rock-matrix travel time log as a function of borehole depth.

[c30]

A method for evaluating a gas fractional volume in a gas-liquid sample, comprising:

acquiring a bulk density measurement;
acquiring a nuclear magnetic resonance measurement; and

determining the gas fractional volume from the bulk density measurement and the nuclear magnetic resonance measurement.

[c31] The method of claim 30, further comprising computing a density porosity from the bulk density measurement and a fluid density, and wherein the determining the gas fractional volume is performed using the density porosity and the nuclear magnetic resonance measurement.

[c32] A method for evaluating a formation traversed by a borehole, comprising:

acquiring a dielectric measurement;

determining a dielectric-derived water volume from the dielectric measurement;

acquiring a suite of nuclear magnetic resonance measurements;

deriving a water volume and an apparent heavy oil volume from the nuclear magnetic resonance measurements; and

comparing the dielectric-derived water volume with the nuclear magnetic resonance derived water volume and the apparent oil volume to produce a true heavy oil volume.